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NATIONAL DAM SAFETY PROGRAM, LAKE SPRINGFIELD DAM (MO 20023), O--ETC(U)
SEP 79 R J KIMBALL, K H CHUANG DACW43-79-C-0034

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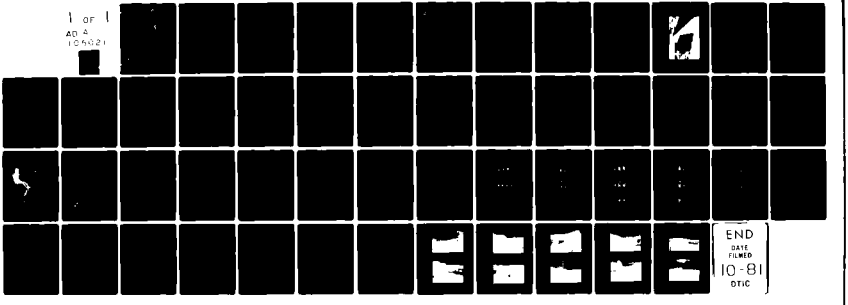

LEVEL II

OSAGE - GASCONADE BASIN

LAKE SPRINGFIELD DAM

GREENE COUNTY, MISSOURI

MO 20023

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

SEPTEMBER 1979

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	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Phase I Dam Inspection Report National Dam Safety Program Lake Springfield Dam (MO 20023) Greene County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report.
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) L. Robert Kimball and Associates	8. CONTRACT OR GRANT NUMBER(s) DACW43-79-C-0034
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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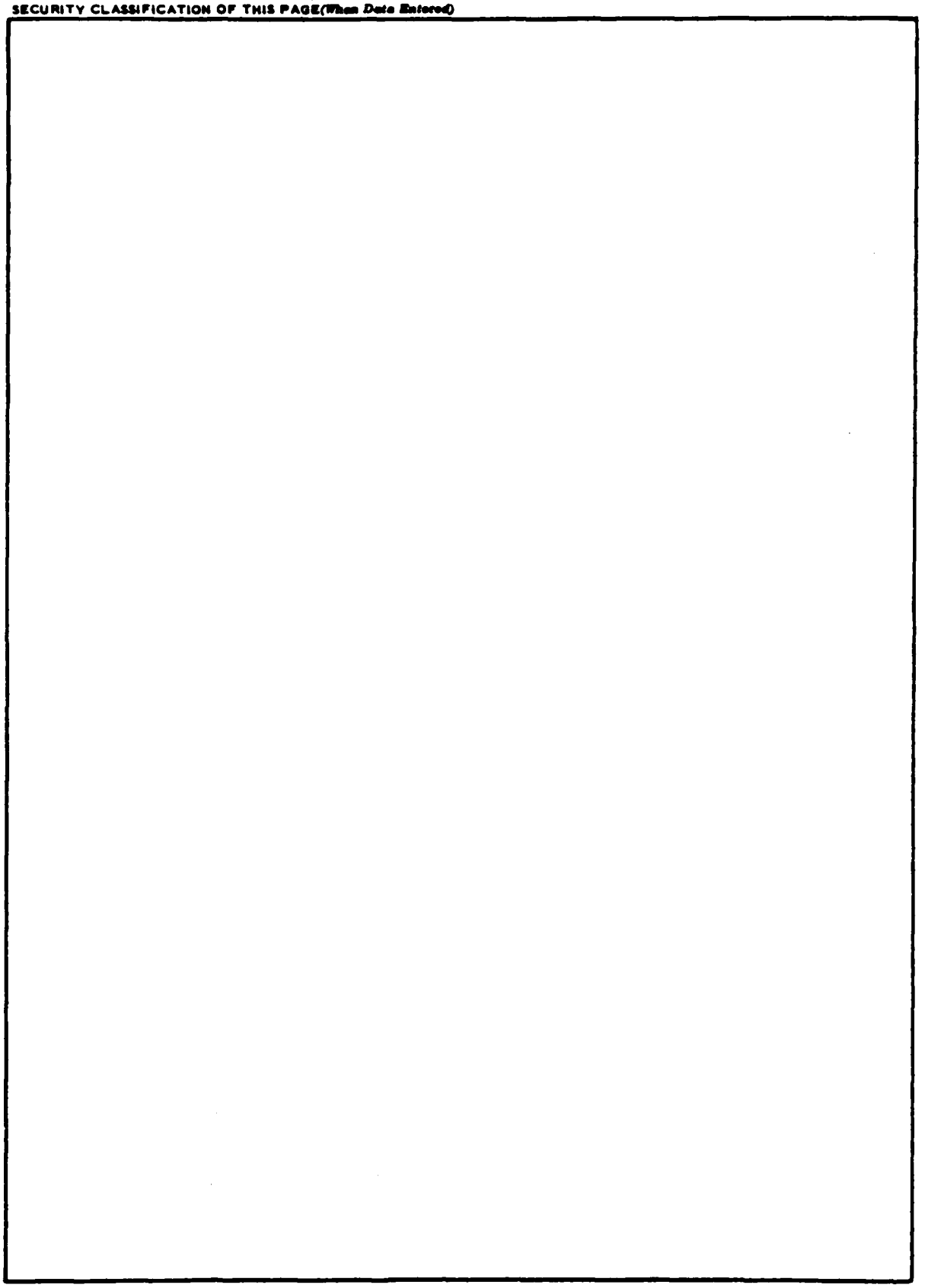

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LAKE SPRINGFIELD DAM

GREENE COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20023

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY

L. ROBERT KIMBALL AND ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS
EBENSBURG, PENNSYLVANIA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

SEPTEMBER 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lake Springfield Dam Phase I Inspection Report (MO 30012)

This report presents the results of field inspection and evaluation of the Lake Springfield Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SIGNED

SUBMITTED BY: _____ 18 SEP 1979
Chief, Engineering Division — Date

SIGNED

APPROVED BY: _____ 18 SEP 1979
Colonel, CE, District Engineer — Date

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM	Lake Springfield Dam
STATE LOCATED	Missouri
COUNTY LOCATED	Greene
STREAM	James River
DATE OF INSPECTION	June 6, 1979

Lake Springfield Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of federal and state agencies, professional engineering organizations and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dams are in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The dam is in the intermediate size classification. The downstream affected area includes a power plant immediately downstream, several dwellings and U.S. Route 160 approximately 2.5 miles downstream.

Based on the downstream exposure and the size classification, the spillway design flood for this dam is the Probable Maximum Flood (PMF). The PMF is that flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

The dam is capable of controlling 57% of the PMF without overtopping the earth embankment section. Overtopping of the embankment with a significant depth of water or for an extended period of time will cause failure of the earth embankment portion of the dam. Using definitions provided by the Corps of Engineers, the spillway is termed inadequate. However, the spillway is capable of controlling the 100 year frequency flood.

Deficiencies visually observed for Lake Springfield Dam were the inadequate spillway and no facilities to lower or drain the reservoir. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These deficiencies should be remedied at the direction of a professional engineer knowledgeable in dam design and construction.

It is recommended that the owner take action to correct or control the deficiencies described.

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Geologist

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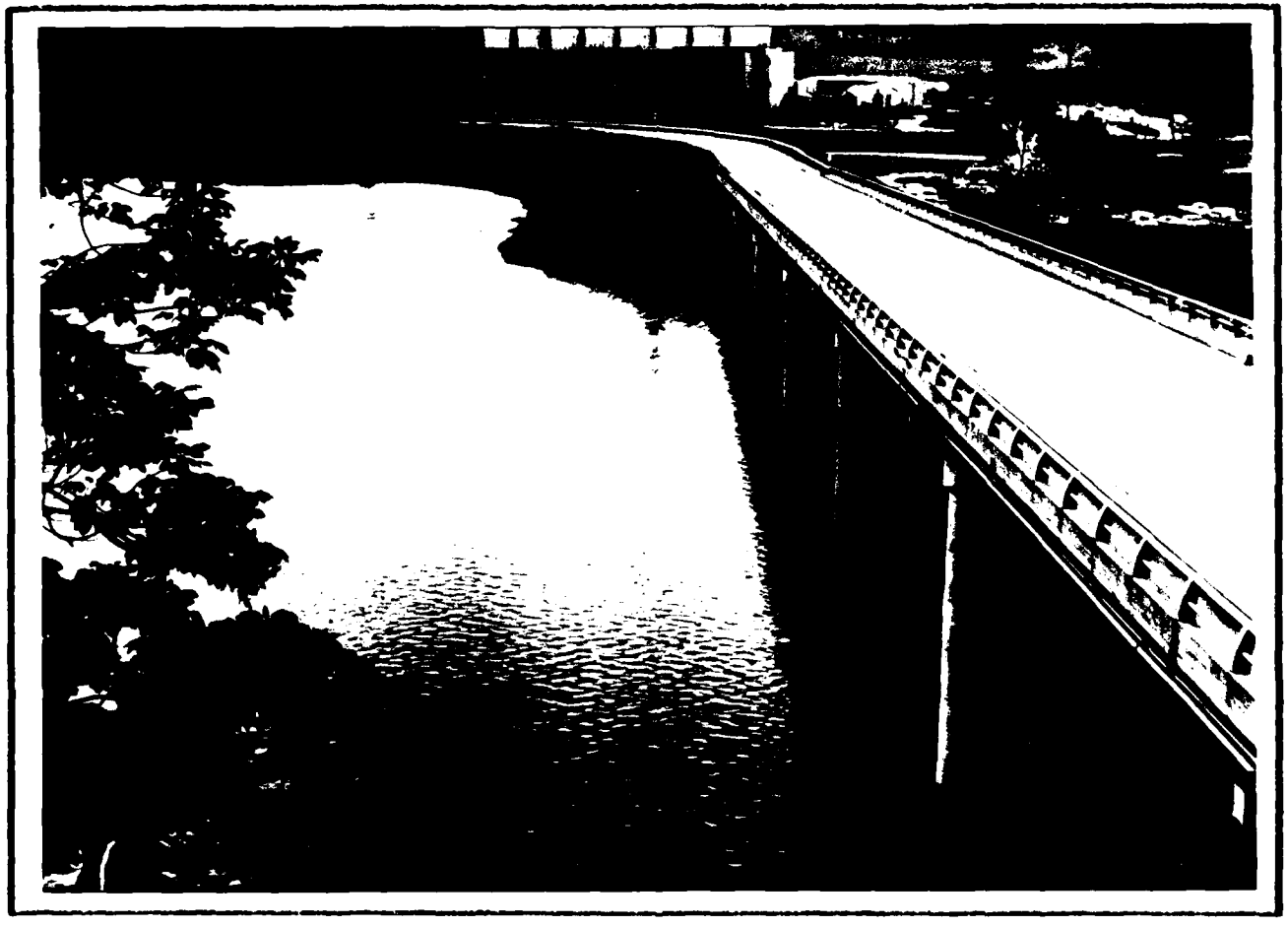

Lake Springfield Dam – overview

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE SPRINGFIELD DAM - ID NO. 20023

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Lake Springfield Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dams with respect to safety, based on available data and visual inspection, in order to determine if the dam poses hazards to to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam was furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Lake Springfield Dam is an earthfill dam with a concrete ogee spillway section located on the right abutment. The earth embankment section is approximately 1400 feet long with a maximum height of approximately 46 feet. The upstream slope is 2H:1V above elevation 1140. Below elevation 1140 the upstream slope is 3H:1V. Riprap is present to approximately elevation 1146. The downstream slope is 2H:1V. A rock toe is present in the maximum section. The remainder of the embankment is homogeneous. The earth embankment section has a double curve alignment. (See Appendices A & C). A paved county road is present across the crest of the dam. The crest is 40 feet wide.

The spillway consists of a concrete gravity ogee section. The maximum height of the gravity section is 30 feet. A 10 foot deep cutoff is present on the upstream toe of the gravity section. The upstream slope of the dam is vertical. A 30 foot long concrete apron extends below the toe of the gravity section with a 4 foot deep cutoff. The spillway is 563 feet long but contains six concrete piers which support a highway bridge as part of the county road.

There are no facilities provided to drain or lower the lake level. Lake Springfield Dam is used for cooling water for the James River power plant. The James River power plant has three 60" diameter intakes from the lake. Water is discharged back into Lake Springfield through two 60" diameter pipes and one 84" diameter pipe.

b. Location. Lake Springfield Dam is located approximately 5 miles south of Springfield, Missouri on the James River. The dam can be located (Section 19 and 20, Township 28 North, Range 28 West) on the Nixa, Missouri 7.5 minute U.S.G.S Quadrangle.

c. Size Classification. Lake Springfield Dam is an intermediate size dam (45 feet high, 20,077 acre-feet).

d. Hazard Classification. Lake Springfield Dam is a high hazard dam. Downstream conditions indicate that loss of life is probable should failure of the dam occur.

e. Ownership. Lake Springfield Dam is owned by Springfield City Utilities. Correspondence should be addressed to:

Mr. David Plank
Springfield City Utilities
301 East Central Street
Jewell P.O. Box 551
Springfield, MO 65801
417-831-8520

f. Purpose of Dam. Lake Springfield Dam is used to supply cooling water to the James River power plant.

g. Design and Construction History. Lake Springfield Dam was designed by Burns and McDonnell. Construction of the dam was initiated in 1956. Construction drawings were available for review. No other design reports or construction history was available.

h. Normal Operating Procedures. No operating records exist. The reservoir is maintained at the spillway crest with the excess inflow discharging over the spillway. Water is recirculated through the intakes and discharges to cool water from the power plant.

1.3 PERTINENT DATA

a. Drainage Area. 303 square miles

b. Discharge at Dam Site (cfs).

(1)	Maximum known flood at dam site	Unknown
(2)	Spillway capacity at top of dam	190,118
(3)	Drain Line	None

c. Elevation (feet) - Based on spillway crest elevation 1140.0 shown on construction drawings)

(1)	Top of dam	1161.2	
(2)	Spillway crest	1140.0	
(3)	Normal pool	1140.0	
(4)	Maximum pool (PMF)	1165.2	
(5)	Tailwater (day of inspection)	1118.8	(200 cfs)
(6)	Streambed at centerline of dam	1116.0	

d. Reservoir (feet).

(1)	Length of maximum pool	24,000
(2)	Length of normal pool	12,000

e. Storage (acre-feet).

(1)	Top of dam	20,077
(2)	Spillway crest	2,806
(3)	Normal pool	2,806
(4)	Maximum pool (PMF)	29,938

f. Reservoir Surface (acres).

(1)	Top of dam	1250
(2)	Spillway crest	360
(3)	Normal pool	360
(4)	Maximum pool (PMF)	1400

g. Dam.

(1)	Type		Earth embankment with concrete gravity spillway
(2)	Length -embankment		1400 feet
	-spillway (total with piers)		563 feet
(3)	Height -embankment		45 feet
	-spillway		30 feet
(4)	Top width		40 feet
(5)	Side slopes -embankment, upstream		2H:1V above elevation 1140 3H:1V below elevation 1140
		downstream	2H:1V
	-concrete section		
		upstream	Vertical
		downstream	Variable
(6)	Zoning		Homogeneous embankment with a rock toe
(7)	Grout curtain		Yes

h. Spillway.

(1)	Type	Concrete gravity
(2)	Length (total with piers)	563 feet

(3)	Net weir length	539 feet
(4)	Crest elevation	1140.0
(5)	Upstream channel	Lake
(6)	Downstream channel	James River
(7)	Weir shape	Ogee

i. Drawdown Facilities — None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN. The construction drawings were available for review. No other design reports were available. Test borings with the construction drawings show that one boring was stopped in a void. The foundation was apparently grouted during construction.

2.2 CONSTRUCTION. No information was available on construction of the dam.

2.3 OPERATION. No operating records exist.

2.4 EVALUATION.

a. Availability. Very little information is available on the design or construction of the dam.

b. Adequacy. The field surveys and visual inspections presented herein are considered adequate to support the conclusion of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The onsite inspection of Lake Springfield Dam was conducted by personnel of L. Robert Kimball and Associates accompanied by personnel from the owner's engineering staff on June 6, 1979. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works, and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.

b. Project Geology. The bedrock underlying Lake Springfield Dam consists of the Mississippian aged Burlington-Keokuk limestone formation, which is part of the Osagean Series. This unit may be over 200 feet thick.

This formation is a coarsely crystalline, crinoidal limestone which is white to gray in color. Where the beds are dolomitic, as in the spillway at McDaniel Lake, the color is buff to brown. These beds are rare, however. The formation varies from thin bedded to massive, but is usually medium bedded and weathers to even beds.

Grey to white cherts are often contained within the formation in the form of nodules or beds. The chert weathers to white or brown boulders which become tripolitic and reddish brown upon extreme weathering. The cherty section of the formation is probably in the higher part of the formation and appears to have been eroded from many areas.

Water moving through the limestone has dissolved it in many places, forming a highly uneven bedrock surface, enlarged joints and bedding planes, and caverns. Irregularly shaped pinnacles, some of which may be 10 or 15 feet high, are also common in many areas. These features lie between major "paths" of lateral water movement through residual material toward enlarged joints or bedding planes.

Lake Springfield lies approximately four miles from the Sac River and Kinwer Bridge Faults. These are northwest-southeast trending faults, each with displacements of about 50 feet. The strata in this area dip about 1/2 degree to the southwest.

c. Dam and Spillway. Visual inspection of the dam indicated the structure was in good conditions. From a brief survey conducted during the inspection, it was determined that several low spots are present on the crest of the embankment. The low spot

on the dam was determined to be 1161.2. The crest of the dam serves as a county road. This road is paved with guardrails on either side. Both the upstream and the downstream slope appear to be in good condition although vegetation may have obscured minor deficiencies.

The concrete gravity spillway appeared to be in good condition. From visual examination, the crest appeared to be even. Water was discharging over the entire crest equally. Close examination of the spillway was not possible because of water discharging over the spillway. In addition, cracks, seepage or spalling of the concrete was obscured because of the full flow over the ogee section. The upstream condition of the concrete and the condition below the tailwater were unobserved. Five concrete piers are located on the spillway to support a bridge over the spillway. The right abutment is formed by a rock cliff.

d. Outlet Works and Drainlines. There are no facilities to drain or lower the reservoir. The power plant has three large intakes to draw water off the lake and three large return lines to return heated water to the lake for cooling. In addition, the power plant has several small discharge lines which discharge below the toe of the dam. These small discharge lines are too small to draw down the reservoir.

e. Reservoir Area. No pertinent problems were noted in the reservoir area. The watershed consists of woodland and farmland.

f. Downstream Channel. Discharges from the spillway enter the James River. The James River has a moderately wide flood plain.

3.2 EVALUATION. The visual inspection did not reveal any signs of instability. The dam appeared to be in good condition. Water flowing over the spillway weir did not permit close examination of the concrete. In addition, it was impossible to examine the upstream portion of the concrete gravity section and the portion below the tailwater.

Complete evaluation of the structure cannot be made without a detailed stability, stress and seepage analysis.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES. The reservoir is maintained at the spillway crest at all times. Water is drawn off the reservoir and recirculated for cooling purposes. No other operational procedures are performed. Operation of the intakes are conducted by the power plant personnel.

4.2 MAINTENANCE OF DAM. Maintenance of the dam appears to be good. Maintenance of the dam is conducted by city personnel.

4.3 MAINTENANCE OF OPERATING FACILITIES. The dam itself has no operating facilities. The power plant has three intakes and three discharges from the reservoir. These facilities are maintained adequately by power plant personnel.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT. There is no warning system in effect.

4.5 EVALUATION. Maintenance of the dam and operating facilities is considered good. There is no warning system in effect to warn downstream residences of large spillway discharges or failure of the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There are no hydraulic and hydrological design data available.

b. Experience Data. The drainage area was developed using the U.S.G.S. quadrangle sheet. The lake surface area was determined by planimetering the quadrangle sheet and surface contour lines within the drainage area on the U.S.G.S. quadrangle sheets. The spillway and dam layout was made from surveys conducted during the inspection.

c. Visual Observations. The dam is an earth embankment with a concrete gravity spillway. Because of the paved crest of the earth embankment section, the embankment should be able to withstand minor overtopping. The total spillway length is 563 feet. Six piers located on the spillway reduce the effective length of the spillway to 539 feet.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway. (The flood that may be expected from the most severe combination of critical meterologic and hydrologic conditions that are reasonably possible in the region.)

The Corps of Engineers, St. Louis District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydraulic Engineering Center (HEC) U.S. Army Corps of Engineers, Davis California, July, 1978. The major methodoligies or key input data for this program are discussed in Appendix B.

To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to assume that the water level prior to flood was at the spillway crest (elevation 1140.0).

Complete summary sheets of the computer output are presented in Appendix B. To facilitate review, the major results of the overtopping analysis are presented below:

Peak Inflow	341,578 cfs
Spillway Capacity	PMF - 190,118 cfs

Ratio of PMF	Maximum Reservoir Water Surface	Maximum Depth over dam, ft.	Maximum Outflow (cfs)	Duration of Overtopping, (hrs.)
.10	1146.60	0.00	33,106	0.00
.50	1159.26	0.00	164,557	0.00
.60	1161.73	0.53	197,934	1.00
1.00	1168.23	7.03	334,105	4.25

The Corps of Engineers Spillway Design Flood for an intermediate size dam is the PMF. The spillway is capable of controlling approximately 57% of the PMF without overtopping the embankment. According to the Corps of Engineers definition, the spillway is termed inadequate. The PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillway is considered adequate to pass the 100 year frequency flood.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations did not reveal any signs of immediate instability. No zones of cracking or deterioration of the concrete spillway were noted, however, much of the spillway was obscured because of flow over the spillway and the high lake level and presence of the tailwater. In addition, no signs of instability were noted on the earth embankment section.

b. Design and Construction Data. The only design data available were the construction drawings. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. In addition, no information on construction of the dam was available.

c. Operating Records. No operating records are kept on the structure.

d. Post Construction Changes. To our knowledge no post construction changes have been made to the dam.

e. Seismic Stability. The dam is located in seismic zone 2 to which the guidelines assign a "moderate" damage potential. No seismic stability analysis has been conducted.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. The visual observations, review of available data, hydrologic calculations and past operational performance indicated that Lake Springfield Dams' spillway is inadequate. The spillway is capable of controlling 57% of the PMF without overtopping the earth embankment. The structural adequacy of the dam is unknown. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. The structure should be evaluated for critical loading conditions.

The dam appears to be in good condition. No signs of instability were noted on the earth embankment section or the concrete gravity spillway section. However, the presence of water discharging over the spillway and the high lake level and presence of the tailwater obscured much of the concrete features.

It must be noted that dams change and deteriorate with age. Safety reviews for this structure should be made on an on-going basis. Periodic safety inspections should be conducted of the dam.

b. Adequacy of Information. Complete assessment of the structural stability of the structure cannot be made because of the limited design data and construction data. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The deficiencies described herein are serious and corrective actions listed below should be initiated immediately. Priority should be given to increasing the spillway capacity. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

d. Need for Phase II. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. A detailed hydraulic and hydrologic study should be conducted by a registered professional engineer knowledgeable in dam design to increase spillway capacity. Remedial modifications should be conducted to increase the spillway capacity. Additional spillway capacity can be obtained by increasing the spillway size and/or the height of the dam with considerations for energy dissipating structures.

b. The stability of the earth embankment section and the concrete spillway section should be documented by a professional engineer experienced in the design and construction of dams.

c. A means of lowering the lake level or draining the lake should be provided.

d. Institute a formal inspection program to be conducted at regular intervals.

e. Institute a formal warning system to warn downstream residences of high spillway discharges or failure of the dam.

APPENDIX A

DRAWINGS

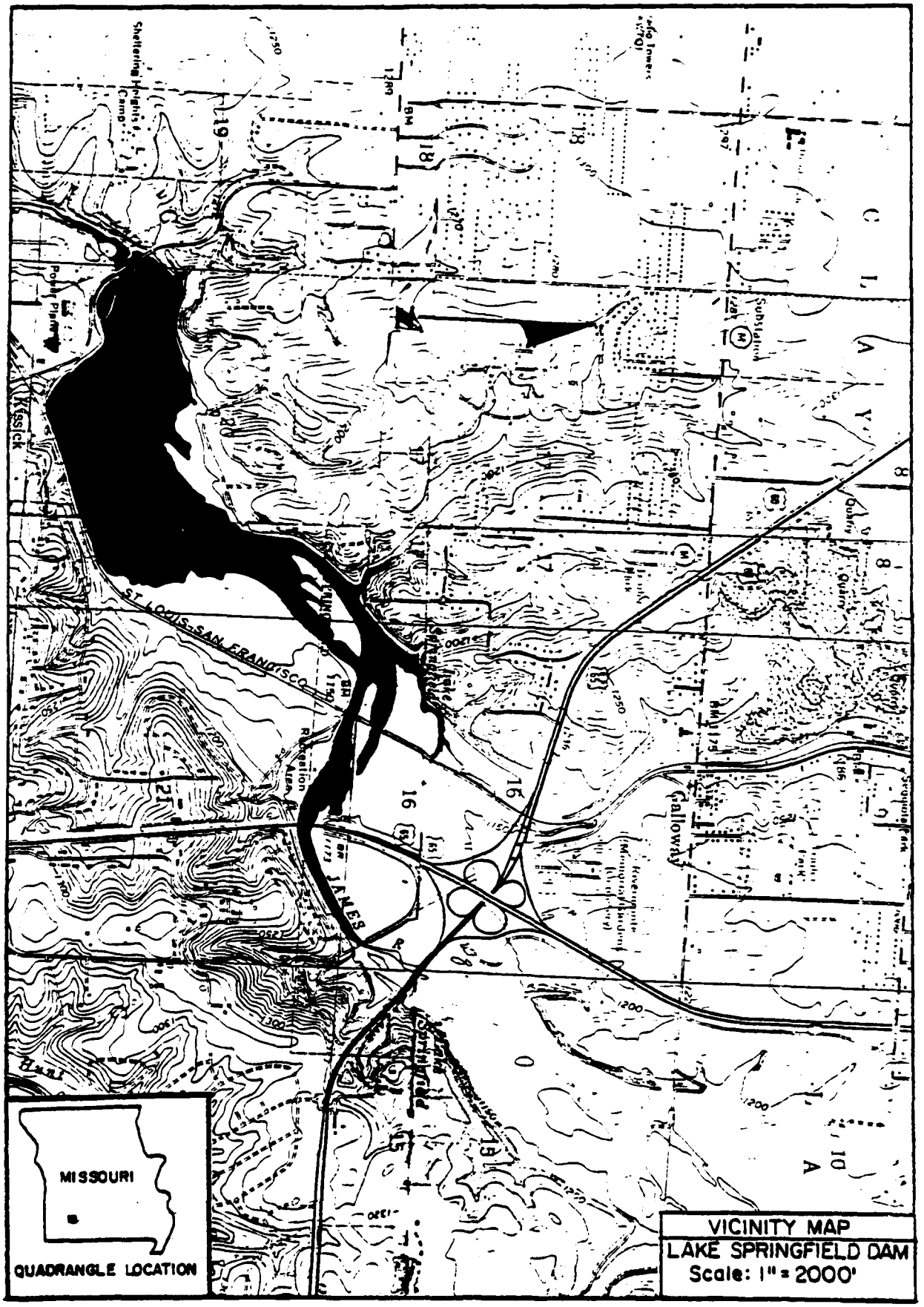

MISSOURI
QUADRANGLE LOCATION
VICINITY MAP
LAKE SPRINGFIELD DAM
Scale: 1" = 2000'

Figure 1

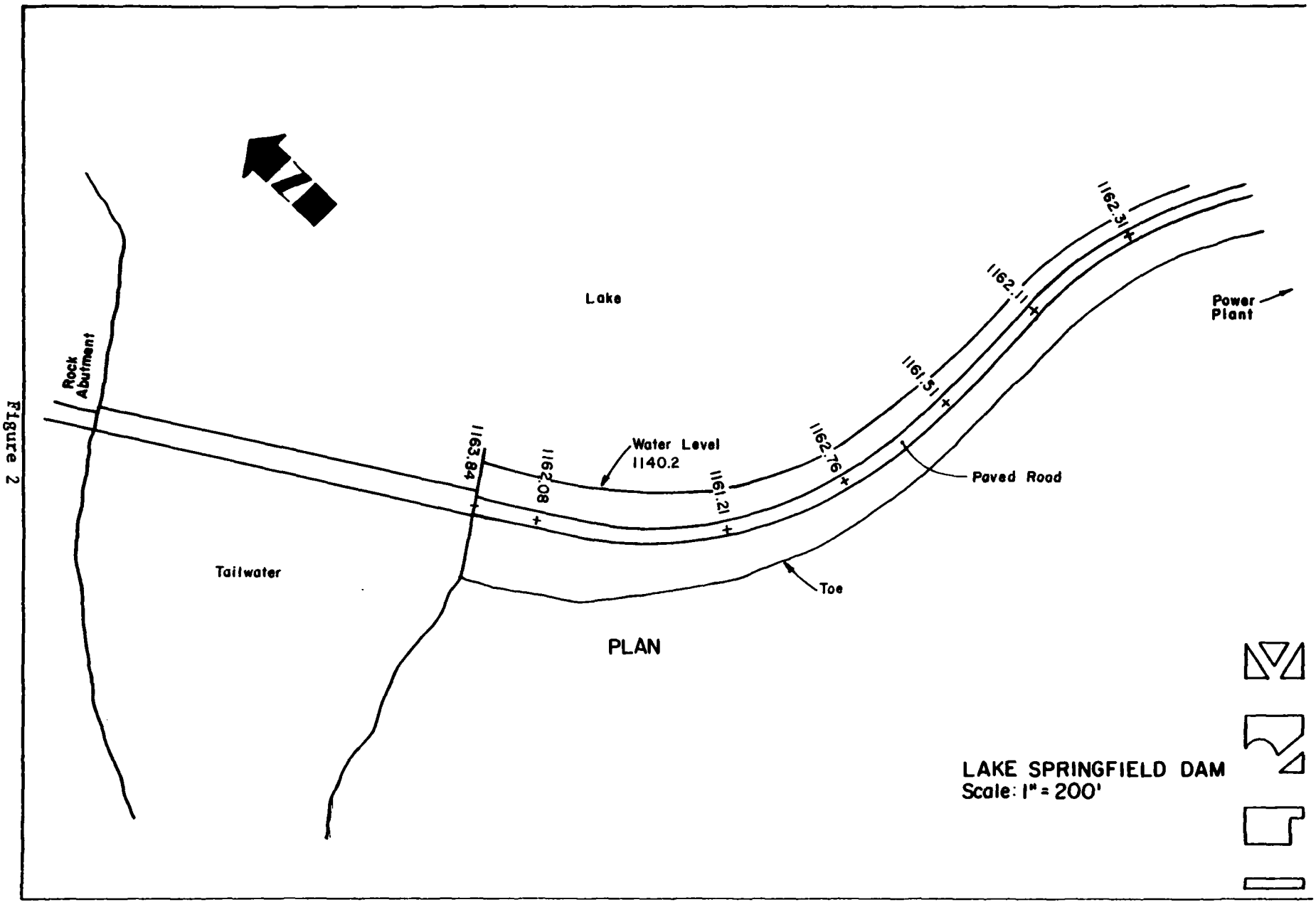

Lake
Rock Abutment
Tailwater
Water Level
1140.2
1163.84
1162.08
1161.21
1162.76
1161.51
1162.11
1162.31
Paved Road
Toe
Power Plant
PLAN
LAKE SPRINGFIELD DAM
Scale: 1" = 200'

Figure 2

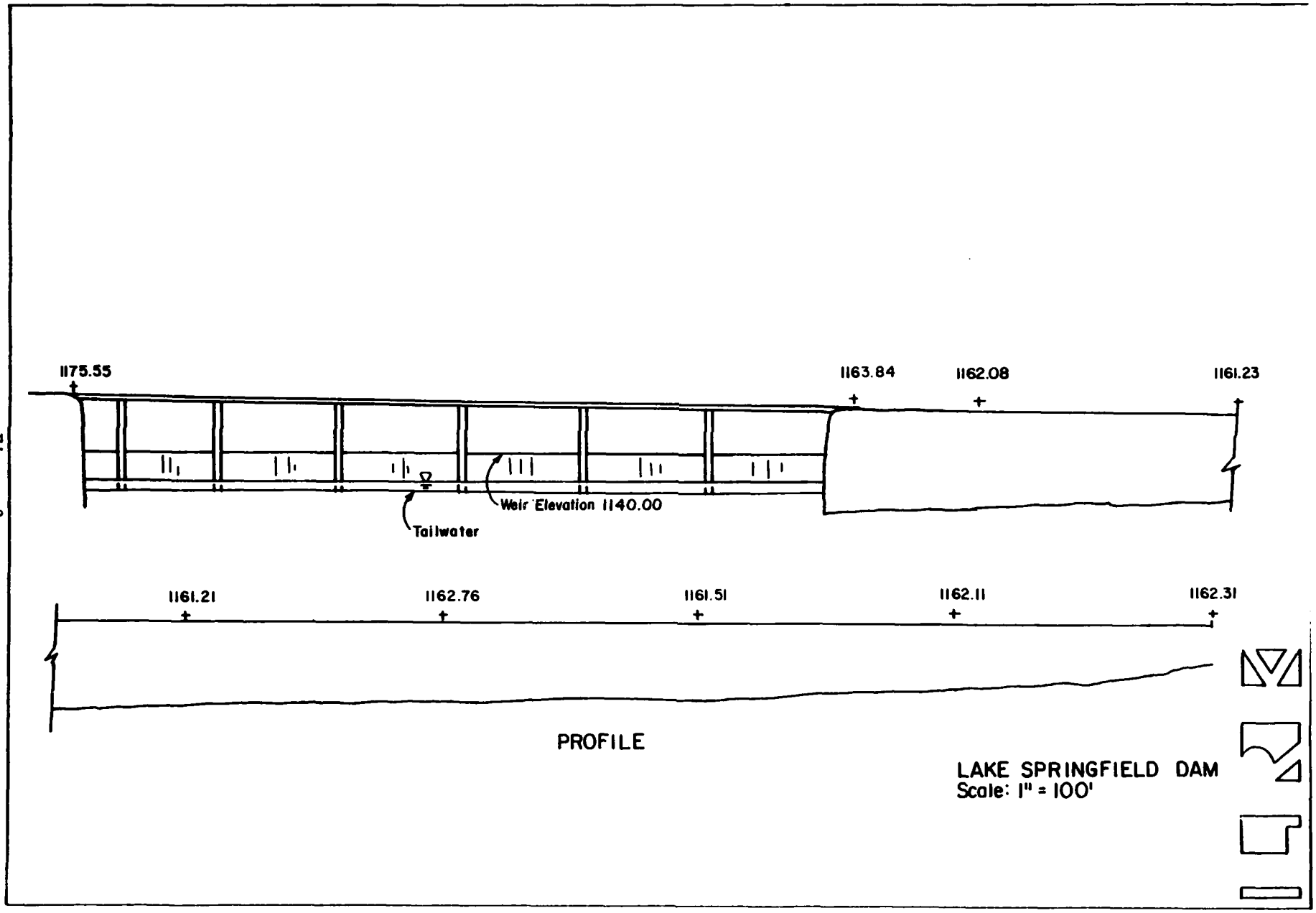

1175.55
1163.84
1162.08
1161.23
Weir Elevation 1140.00
Tailwater
1161.21
1162.76
1161.51
1162.11
1162.31
PROFILE
LAKE SPRINGFIELD DAM
Scale: 1" = 100'

Figure 3

APPENDIX B

HYDROLOGY AND HYDRAULICS

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 48 hour storm duration is assumed with total depth distributed over 6 hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6 hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The non-peak 6 hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by deduction of infiltration losses appropriate to the soil, land use, and antecedent moisture conditions.

The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillways, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillways, and top of dam are defined by elevation-discharge curves.

Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

The above analysis has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE SPRINGFIELD
I.D. NUMBER 20023
SHEET NO. 1 OF 3
BY O.T.M. DATE 7-13-79

LAKE SPRINGFIELD

DRAINAGE AREA

AREA = 303 mi^2 (ST. LOUIS DISTRICT C.O.E.)

UNIT HYDROGRAPH PARAMETERS

KIRPICH METHOD:

t_R = 14.2 HRS. LAG (L) = 0.6 t_R = 9.5 HRS
WHERE LENGTH (L) = 190,000 FT
HEIGHT (H) = 550 FT.
(FROM, TIME OF CONCENTRATION NOMOGRAPH, KENTUCKY BUREAU OF HIGHWAYS)

CURVE NUMBER METHOD:

$$\text{LAG (L)} = \frac{l^{0.8}(S+1)^{0.7}}{1900\, Y^{0.5}} = \frac{(190000)^{0.8}(3.04)^{0.7}}{1900\,(3.8)^{0.5}}$$

$$= \frac{(16711)(2.2)}{3703} = 9.8 \text{ HRS}$$

WHERE l = GREATEST FLOW LENGTH IN FEET.

$S = \frac{1000}{CN} - 10$ AND CN = CURVE NO.
Y = AVERAGE SLOPE (%)

LOSS RATE AND BASE FLOW

STRTL = 1 INCH
CNSTL = 83 *SCS CURVE NUMBER
STRTQ = 1.5 CFS/mi^2
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.5

*UTILIZED ANTECEDENT MOISTURE CONDITION III

PROBABLE MAXIMUM STORM

FROM H.R. NO. 33

PMP INDEX RAINFALL (ZONE 7) = 27.0 INCHES
R_6 = 69%, R_{12} = 85%, R_{24} = 96%, R_{48} = 108%

ELEVATION-AREA-CAPACITY RELATIONSHIP

SPILLWAY CREST ELEV. = 1140', AREA = 360 ACRES
INITIAL STORAGE = 2425 AC.FT

ELEV. 1150', AREA ≈ 800 ACRES

FROM CONIC METHOD FOR RESERVOIR VOLUME. FLOOD HYDROGRAPH PACKAGE (HEC-1). DAM SAFETY VERSION (USERS MANUAL).

$H = 3V/A = 3(2425)/360 = 20.2'$

ELEV. WHERE CAPACITY EQUALS ZERO:
1140' - 20.2' = 1119.8'

AREA (AC)	0	360	500	800	1000	1250	1600
ELEV. (FT)	1119.8	1140	1143	1150	1155	1161	1170

SPILLWAY DISCHARGE

SPILLWAY CREST ELEV. = 1140'

$Q_1 = CLH^{3/2}$ (OGEE, WEIR), C = 3.6, l_{ess} = 539'

$Q_2 = CA\sqrt{2gh}$ (ORIFICE), C = 0.6, A ≈ 14,014 Ft^2

$Q_3 = CLH^{3/2}$ (BROAD CREST WEIR), C = 3.0, l = 563'

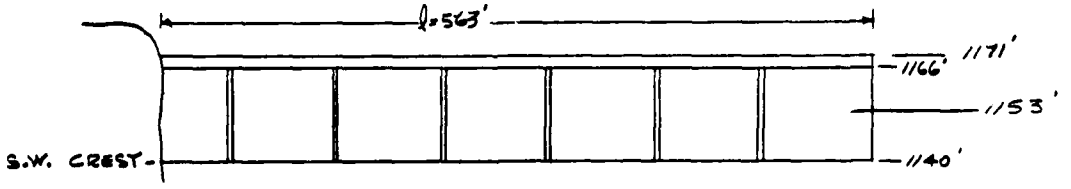
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME LAKE SPRINGFIELD
I.D. NUMBER 20023
SHEET NO. 3 OF 3
BY OTM DATE 8-20-79

DISCHARGE CURVE

ELEV. (FT.)	WEIR h_1 (FT.)	WEIR Q_1 (cfs)	ORIFICE h_2 (FT.)	ORIFICE Q_2 (cfs)	WEIR h_3 (FT.)	WEIR Q_3 (cfs)	DISCHARGE Q (cfs)
1140	0	—					0
1142	2	5488					5488
1144	4	15523					15523
1146	6	28518					28518
1148	8	43906					43906
1150	10	61361					61361
1155	15	112727					112727
1160	20	173555					173555
1165	25	242550					242550
1166	26	257248					257248
1168	28	287494	15	261338			261338
1170	30	318840	17	278215			278215
1171	31	334914	18	286281			286281
1175	35	401785	22	316496	4	13512	330008
1180	40	490887	27	350621	9	45603	396224
1185	45	585747	32	381708	14	88475	470183
1190	50	686035	37	410447	19	139881	550328
1195	55	791471	42	437301	24	198585	635886
1200	60	901816	47	462600	29	263771	726371

NOT TO SCALE:



l_{eff} = 563' - [6(4)] = 539' , PIER WIDTH = 4'

OVERTOP PARAMETERS

TOP OF DAM (LOW SPOT) = 1161.2'
COEFFICIENT OF DISCHARGE = 3.0 (BROAD CREST)
LENGTH = 1400'

```
        **********************************
        FLOOD HYDROGRAPH PACKAGE (HEC-1)
        DAM SAFETY VERSION      JULY 1978
         LAST MODIFICATION  26 FEB 79
        **********************************

   1            A1     ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
   2            A2     HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE SPRINGFIELD DAM
   3            A3     RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (MISSOURI-20023)
   4            B   192      0      15   [illegible]   0      0       0       0   [illegible]
   5            B1    5
   6            J     1      4       1
   7            J1    .1     .5      .6      1
   8            K     0      1
   9            K1     INFLOW TO RESERVOIR
  10            M     1      2     803   [illegible]
  11            P          27.0     69      83      96     108
  12            T                                                  -1     -83
  13            W2          8.5
  14            X  [illegible]  .05  [illegible]
  15            K     1      2
  16            K1     ROUTE THROUGH RESERVOIR
  17            Y                             1       1
  18            Y1    1                                         -1140     -1
  19            Y4  1140   1142   1144    1146    1148    1150    1155    1160    1165    1166
  20            Y5  1168   1170   1171    1175    1180    1185    1190    1195    1200  [illegible]
  21            Y6    0    3490  13820   28820  [illegible]  61368  112730  178560  [illegible]  257850
  22            Y6 [illegible] 276220 286880 [illegible] [illegible] 470160 590330 635650 [illegible]
  23            SA    0     100    200     360     500     800    1000    1250    1500    1600
  24            SE  1120   1128   1134    1140    1143    1150    1155    1161    1167    1170
  25            SS  1140
  26            SD 1161.2    310     1.5    1450
  27            SL   229    425    825    1175    1375    1600    1450    2900
  28            SV 1161.2  1161.8  1162.1  1162.1  1162.8  1163.8   1166    1200
  29            K     99
```

B-5

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE 79/08/21.
TIME 13.47.33.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF LAKE SPRINGFIELD DAM
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (MISSOURI-20023)

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
192	0	15	0	0	0	0	0	0	0

JOPER LRDRT ITRACE
0 0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RATIOS= .10 .100 1.000 1.100

****

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

3/11

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	303.00	0.00	303.00	1.00	0.000	0	[illegible]	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	27.00	69.00	[illegible]	96.00	108.00	0.00	[illegible]

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-83.00	0.00	0.00

CURVE NO = -83.00 WETNESS = [illegible] EFFECT CN = 83.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= 8.50

RECESSION DATA

STRTQ= [illegible] QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 72 END OF PERIOD ORDINATES, LAG= [illegible] HOURS, CP= [illegible] VOL= 1.00

147.	295.	442.	698.	1042.	1386.	1740.	2183.	2625.	3068.
3606.	4196.	4786.	5415.	6202.	6988.	7775.	8672.	9606.	10540.
11430.	12217.	13003.	13790.	14368.	14908.	15449.	15892.	16187.	16482.
[illegible]	[illegible]	16887.	[illegible]	[illegible]	[illegible]	16830.	[illegible]	[illegible]	16387.
[illegible]	[illegible]	15223.	14879.	[illegible]	[illegible]	13761.	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	10796.	10206.	[illegible]	[illegible]	8613.	[illegible]	[illegible]	[illegible]
6993.	6649.	6349.	6054.	5759.	5486.	5241.	4995.	4749.	4570.
4390.	4211.	4031.	3852.	3672.	3496.	3349.	3201.	3054.	2906.
2759.	2611.	2474.	2375.	2277.	2179.	2080.	1982.	1884.	1793.
[illegible]	[illegible]	1571.	1498.	[illegible]	1350.	1284.	[illegible]	[illegible]	1122.
1068.	1014.	960.	914.	[illegible]	841.	804.	767.	730.	693.
662.	639.	608.	581.	554.	527.	500.	478.	458.	439.
419.	399.	380.	360.	344.	330.	315.	300.	285.	271.
256.	246.	236.	226.	216.	206.	196.	187.	181.	175.
169.	163.	157.	151.	145.	139.	133.	128.	122.	116.
110.	104.	98.	92.	86.	81.	76.	71.	66.	61.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.01	0.00	.01	519.	1.02	.15	97	.05	.04	.01	24738.
1.01	.30	2	.01	0.00	.01	418.	1.02	.30	98	.05	.04	.01	24793.
1.01	.45	3	.01	0.00	.01	345.	1.02	.45	99	.05	.04	.01	24808.
1.01	1.00	4	.01	0.00	.01	315.	1.02	1.00	100	.05	.04	.01	24772.
1.01	1.15	5	.01	0.00	.01	287.	1.02	1.15	101	.05	.04	.01	24644.
1.01	1.30	6	.01	0.00	.01	262.	1.02	1.30	102	.05	.04	.01	24480.
1.01	1.45	7	.01	0.00	.01	240.	1.02	1.45	103	.05	.04	.01	24287.
1.01	2.00	8	.01	0.00	.01	218.	1.02	2.00	104	.05	.04	.01	24071.
1.01	2.15	9	.01	0.00	.01	199.	1.02	2.15	105	.05	.04	.01	23834.
1.01	2.30	10	.01	0.00	.01	182.	1.02	2.30	106	.05	.04	.01	23580.
1.01	2.45	11	.01	0.00	.01	166.	1.02	2.45	107	.05	.04	.01	23316.
1.01	3.00	12	.01	0.00	.01	151.	1.02	3.00	108	.05	.04	.01	23037.
1.01	3.15	13	.01	0.00	.01	137.	1.02	3.15	109	.05	.04	.01	22756.
1.01	3.30	14	.01	0.00	.01	126.	1.02	3.30	110	.05	.04	.01	22470.
1.01	3.45	15	.01	0.00	.01	115.	1.02	3.45	111	.05	.04	.01	22179.
1.01	4.00	16	.01	0.00	.01	105.	1.02	4.00	112	.05	.04	.01	21895.
1.01	4.15	17	.01	0.00	.01	96.	1.02	4.15	113	.05	.04	.01	21627.
1.01	4.30	18	.01	0.00	.01	87.	1.02	4.30	114	.05	.04	.01	21373.
1.01	4.45	19	.01	0.00	.01	80.	1.02	4.45	115	.05	.04	.01	21125.
1.01	5.00	20	.01	0.00	.01	73.	1.02	5.00	116	.05	.04	.01	20903.
1.01	5.15	21	.01	0.00	.01	66.	1.02	5.15	117	.05	.04	.01	20717.
1.01	5.30	22	.01	0.00	.01	61.	1.02	5.30	118	.05	.04	.01	20584.
1.01	5.45	23	.01	0.00	.01	55.	1.02	5.45	119	.05	.04	.01	20491.
1.01	6.00	24	.01	0.00	.01	50.	1.02	6.00	120	.05	.04	.01	20434.
1.01	6.15	25	.02	0.00	.02	46.	1.02	6.15	121	.18	.16	.02	20446.
1.01	6.30	26	.02	0.00	.02	42.	1.02	6.30	122	.18	.16	.02	20538.
1.01	6.45	27	.02	0.00	.02	38.	1.02	6.45	123	.18	.16	.02	20680.
1.01	7.00	28	.02	0.00	.02	35.	1.02	7.00	124	.18	.16	.02	20887.
1.01	7.15	29	.02	0.00	.02	32.	1.02	7.15	125	.18	.16	.02	21177.
1.01	7.30	30	.02	0.00	.02	29.	1.02	7.30	126	.18	.16	.02	21581.

1.01	7.45	31	.02	0.00	.02	27.	1.02	7.45	127	.18	.17	.01	21981.
1.01	8.00	32	.02	0.00	.02	24.	1.02	8.00	128	.18	.17	.01	22499.
1.01	8.15	33	.02	0.00	.02	22.	1.02	8.15	129	.18	.17	.01	23097.
1.01	8.30	34	.02	0.00	.02	20.	1.02	8.30	130	.18	.17	.01	23767.
1.01	8.45	35	.02	0.00	.02	18.	1.02	8.45	131	.18	.17	.01	24520.
1.01	9.00	36	.02	.00	.02	17.	1.02	9.00	132	.18	.17	.01	25372.
1.01	9.15	37	.02	.00	.02	15.	1.02	9.15	133	.18	.17	.01	26307.
1.01	9.30	38	.02	.00	.02	14.	1.02	9.30	134	.18	.17	.01	27327.
1.01	9.45	39	.02	.00	.02	13.	1.02	9.45	135	.18	.17	.01	28442.
1.01	10.00	40	.02	.00	.02	13.	1.02	10.00	136	.18	.17	.01	29652.
1.01	10.15	41	.02	.00	.02	13.	1.02	10.15	137	.18	.17	.01	30956.
1.01	10.30	42	.02	.00	.02	14.	1.02	10.30	138	.18	.17	.01	32373.
1.01	10.45	43	.02	.00	.02	16.	1.02	10.45	139	.18	.17	.01	33905.
1.01	11.00	44	.02	.00	.02	18.	1.02	11.00	140	.18	.17	.01	35549.
1.01	11.15	45	.02	.00	.02	23.	1.02	11.15	141	.18	.17	.01	37299.
1.01	11.30	46	.02	.00	.02	28.	1.02	11.30	142	.18	.17	.01	39139.
1.01	11.45	47	.02	.00	.02	35.	1.02	11.45	143	.18	.17	.01	41070.
1.01	12.00	48	.02	.00	.02	46.	1.02	12.00	144	.18	.17	.01	43091.
1.01	12.15	49	.06	.01	.04	66.	1.02	12.15	145	.48	.45	.02	45223.
1.01	12.30	50	.06	.02	.04	92.	1.02	12.30	146	.48	.45	.02	47466.
1.01	12.45	51	.06	.02	.04	92.	1.02	12.45	147	.47	.45	.01	49811.
1.01	13.00	52	.06	.02	.04	119.	1.02	13.00	148	.47	.45	.01	52274.
1.01	13.15	53	.07	.03	.04	153.	1.02	13.15	149	.56	.54	.01	54872.
1.01	13.30	54	.07	.03	.04	197.	1.02	13.30	150	.56	.54	.01	57606.
1.01	13.45	55	.07	.03	.04	253.	1.02	13.45	151	.56	.54	.01	60478.
1.01	14.00	56	.07	.03	.04	326.	1.02	14.00	152	.56	.53	.01	63500.
1.01	14.15	57	.09	.04	.04	397.	1.02	14.15	153	.70	.69	.01	66703.
1.01	14.30	58	.09	.05	.04	491.	1.02	14.30	154	.70	.69	.01	70081.
1.01	14.45	59	.09	.05	.04	608.	1.02	14.45	155	.70	.69	.01	73658.
1.01	15.00	60	.09	.05	.04	744.	1.02	15.00	156	.70	.69	.01	77466.
1.01	15.15	61	.09	.05	.04	904.	1.02	15.15	157	.71	.70	.01	81518.
1.01	15.30	62	.18	.11	.07	1004.	1.02	15.30	158	3.42	3.40	.02	85929.
1.01	15.45	63	.50	.34	.15	1356.	1.02	15.45	159	3.96	3.93	.04	91100.
1.01	16.00	64	.12	.09	.03	1652.	1.02	16.00	160	.99	.98	.01	96618.
1.01	16.15	65	.08	.06	.02	1987.	1.02	16.15	161	.65	.65	.00	102504.
1.01	16.30	66	.08	.06	.02	2392.	1.02	16.30	162	.66	.65	.00	109127.

1.01	16.45	67	.08	.06	.02	2862.	1.02	16.45	163	.65	.65	.00	116426.
1.01	17.00	68	.08	.06	.02	3376.	1.02	17.00	164	.65	.65	.00	124120.
1.01	17.15	69	.06	.05	.01	3935.	1.02	17.15	165	.51	.51	.00	132232.
1.01	17.30	70	.06	.05	.01	4559.	1.02	17.30	166	.51	.51	.00	140945.
1.01	17.45	71	.06	.05	.01	5228.	1.02	17.45	167	.51	.51	.00	150020.
1.01	18.00	72	.06	.05	.01	5942.	1.02	18.00	168	.51	.51	.00	159477.
1.01	18.15	73	.01	.01	.00	6719.	1.02	18.15	169	.07	.07	.00	169448.
1.01	18.30	74	.01	.01	.00	7565.	1.02	18.30	170	.07	.07	.00	179773.
1.01	18.45	75	.01	.01	.00	8408.	1.02	18.45	171	.07	.07	.00	190300.
1.01	19.00	76	.01	.01	.00	9316.	1.02	19.00	172	.07	.07	.00	201132.
1.01	19.15	77	.01	.01	.00	10289.	1.02	19.15	173	.07	.07	.00	212439.
1.01	19.30	78	.01	.01	.00	11284.	1.02	19.30	174	.07	.07	.00	223727.
1.01	19.45	79	.01	.01	.00	12299.	1.02	19.45	175	.07	.07	.00	235002.
1.01	20.00	80	.01	.01	.00	13355.	1.02	20.00	176	.07	.07	.00	246458.
1.01	20.15	81	.01	.01	.00	14427.	1.02	20.15	177	.07	.07	.00	257818.
1.01	20.30	82	.01	.01	.00	15497.	1.02	20.30	178	.07	.07	.00	268892.
1.01	20.45	83	.01	.01	.00	16540.	1.02	20.45	179	.07	.07	.00	279412.
1.01	21.00	84	.01	.01	.00	17636.	1.02	21.00	180	.07	.07	.00	289189.
1.01	21.15	85	.01	.01	.00	18810.	1.02	21.15	181	.07	.07	.00	298519.
1.01	21.30	86	.01	.01	.00	19948.	1.02	21.30	182	.07	.07	.00	307251.
1.01	21.45	87	.01	.01	.00	20289.	1.02	21.45	183	.07	.07	.00	314693.
1.01	22.00	88	.01	.01	.00	21071.	1.02	22.00	184	.07	.07	.00	321329.
1.01	22.15	89	.01	.01	.00	21803.	1.02	22.15	185	.07	.07	.00	327273.
1.01	22.30	90	.01	.01	.00	22451.	1.02	22.30	186	.07	.07	.00	332142.
1.01	22.45	91	.01	.01	.00	22999.	1.02	22.45	187	.01	.07	.00	335810.
1.01	23.00	92	.01	.01	.00	23486.	1.02	23.00	188	.07	.07	.00	338732.
1.01	23.15	93	.01	.01	.00	23905.	1.02	23.15	189	.07	.07	.00	340841.
1.01	23.30	94	.01	.01	.00	24205.	1.02	23.30	190	.07	.07	.00	341578.
1.01	23.45	95	.01	.01	.00	24440.	1.02	23.45	191	.07	.07	.00	341566.
1.02	0.00	96	.01	.01	.00	24615.	1.03	0.00	192	.07	.07	.00	340897.
									SUM	29.16	26.84	2.32	10475976.
										(741.)	(682.)	(59.)	(********)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	341578.	275146.	102748.	53673.	10305273.

CMS	9672.	7791.	2909.	1520.	291813.
INCHES		8.45	12.62	13.18	12.18
MM		214.56	320.49	334.84	334.84
AC-FT		136436.	203797.	212919.	212919.
THOUS CU M		168292.	251380.	262632.	262632.

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

41.	38.	35.	32.	29.	26.	24.	22.	20.	18.
17.	15.	14.	13.	11.	10.	10.	9.	8.	7.
7.	6.	6.	5.	5.	4.	4.	3.	3.	3.
3.	2.	2.	2.	2.	2.	2.	1.	1.	1.
1.	1.	2.	2.	2.	3.	3.	4.	5.	7.
9.	12.	15.	20.	25.	32.	40.	49.	61.	74.
90.	109.	136.	165.	199.	239.	286.	338.	394.	456.
523.	594.	672.	755.	841.	932.	1029.	1128.	1230.	1335.
1443.	1550.	1654.	1754.	1851.	1945.	2029.	2101.	2160.	2205.
2300.	2349.	2390.	2421.	2444.	2462.	2473.	2478.	2481.	2477.
2464.	2448.	2429.	2407.	2383.	2358.	2332.	2305.	2276.	2247.
2218.	2189.	2163.	2137.	2112.	2090.	2072.	2058.	2049.	2043.
2045.	2054.	2068.	2089.	2118.	2154.	2198.	2250.	2310.	2377.
2452.	2537.	2631.	2733.	2844.	2965.	3096.	3237.	3391.	3555.
3730.	3914.	4107.	4309.	4522.	4747.	4981.	5227.	5487.	5761.
6048.	6350.	6670.	7008.	7366.	7747.	8152.	8583.	9110.	9662.
10250.	10913.	11643.	12414.	13223.	14099.	15002.	15981.	16945.	17977.
19030.	20113.	21244.	22373.	23500.	24646.	25782.	26889.	27941.	28919.
29852.	30725.	31469.	32133.	32727.	33214.	33581.	33873.	34084.	34158.
34157.	34090.								

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	34158.	27819.	10275.	5367.	1030927.
CMS	967.	779.	291.	152.	29181.
INCHES		.84	1.26	1.32	1.32
MM		21.46	32.05	33.48	33.48
AC-FT		13644.	20380.	21292.	21292.

13.	14.	16.	19.	23.	28.	35.	44.	56.	72.
92.	119.	153.	197.	250.	316.	397.	493.	608.	744.
902.	1094.	1356.	1652.	1987.	2392.	2862.	3376.	3935.	4559.
5228.	5942.	6719.	7545.	8408.	9316.	10289.	11284.	12299.	13355.
14427.	15497.	16540.	17536.	18510.	19448.	20289.	21071.	21803.	22451.
22999.	23486.	23905.	24205.	24440.	24615.	24733.	24793.	24808.	24772.
24646.	24480.	24287.	24071.	23834.	23580.	23316.	23037.	22756.	22470.
22179.	21899.	21627.	21373.	21125.	20903.	20717.	20584.	20491.	20434.
20446.	20536.	20680.	20887.	21177.	21542.	21981.	22499.	23097.	23767.
24520.	25372.	26307.	27327.	28442.	29652.	30958.	32373.	33905.	35549.
37299.	39139.	41070.	43091.	45223.	47466.	49811.	52274.	54872.	57606.
60578.	63500.	66709.	70081.	73658.	77466.	81518.	85929.	91100.	96618.
102304.	109127.	116426.	124120.	132232.	140945.	150020.	159477.	169448.	179773.
190300.	201132.	212439.	223727.	235002.	246458.	257818.	268892.	279412.	289189.
298519.	307251.	314693.	321329.	327273.	332142.	335810.	338732.	340841.	341578.
341566.	340897.								

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	[illegible]	[illegible]	102748.	53673.	[illegible]
CMS	[illegible]	[illegible]	2909.	1520.	[illegible]
INCHES		8.45	12.62	13.18	13.18
MM		214.56	320.49	334.84	334.84
AC-FT		136436.	203797.	212919.	212919.
THOUS CU M		[illegible]	[illegible]	262632.	[illegible]

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO

2 1 0 0 0 0 1 0 0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1140.	-1

STAGE	1140.00	1142.00	1144.00	1146.00	1148.00	1150.00	1155.00	1160.00	1165.00
1166.00									
	1168.00	1170.00	1171.00	1175.00	1180.00	1185.00	1190.00	1195.00	1200.00
FLOW	0.00	9490.00	15520.00	28820.00	43910.00	61360.00	112720.00	173560.00	248550.00
257290.00									
	261340.00	278220.00	286280.00	330010.00	396220.00	470180.00	550330.00	635890.00	726370.00
SURFACE AREA=	0.	100.	200.	360.	500.	800.	1000.	1250.	1500.	1600.
CAPACITY=	0.	267.	1150.	2806.	4090.	8599.	13090.	19826.	28065.	32714.
ELEVATION=	1120.	1128.	1134.	1140.	1143.	1150.	1155.	1161.	1167.	1170.

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1140.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1161.2	3.0	1.5	1450.

CREST LENGTH AT OR BELOW ELEVATION	225.	425.	825.	1175.	1375.	1400.	1450.	2900.
	1161.2	1161.5	1162.1	1162.3	1162.8	1163.8	1166.0	1200.0

STATION 2, PLAN 1, RATIO 1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .50	RATIO 3 .60	RATIO 4 1.00
HYDROGRAPH AT	1	303.00	1	34158.	170789.	204947.	341578.
		(784.77)		(967.24)(	4836.21)(	5803.45)(	9672.42)(
ROUTED TO	2	303.00	1	33106.	164557.	197934.	334105.
		(784.77)		(937.47)(	4659.75)(	5604.86)(	9460.81)(

SUMMARY OF DAM SAFETY ANALYSIS

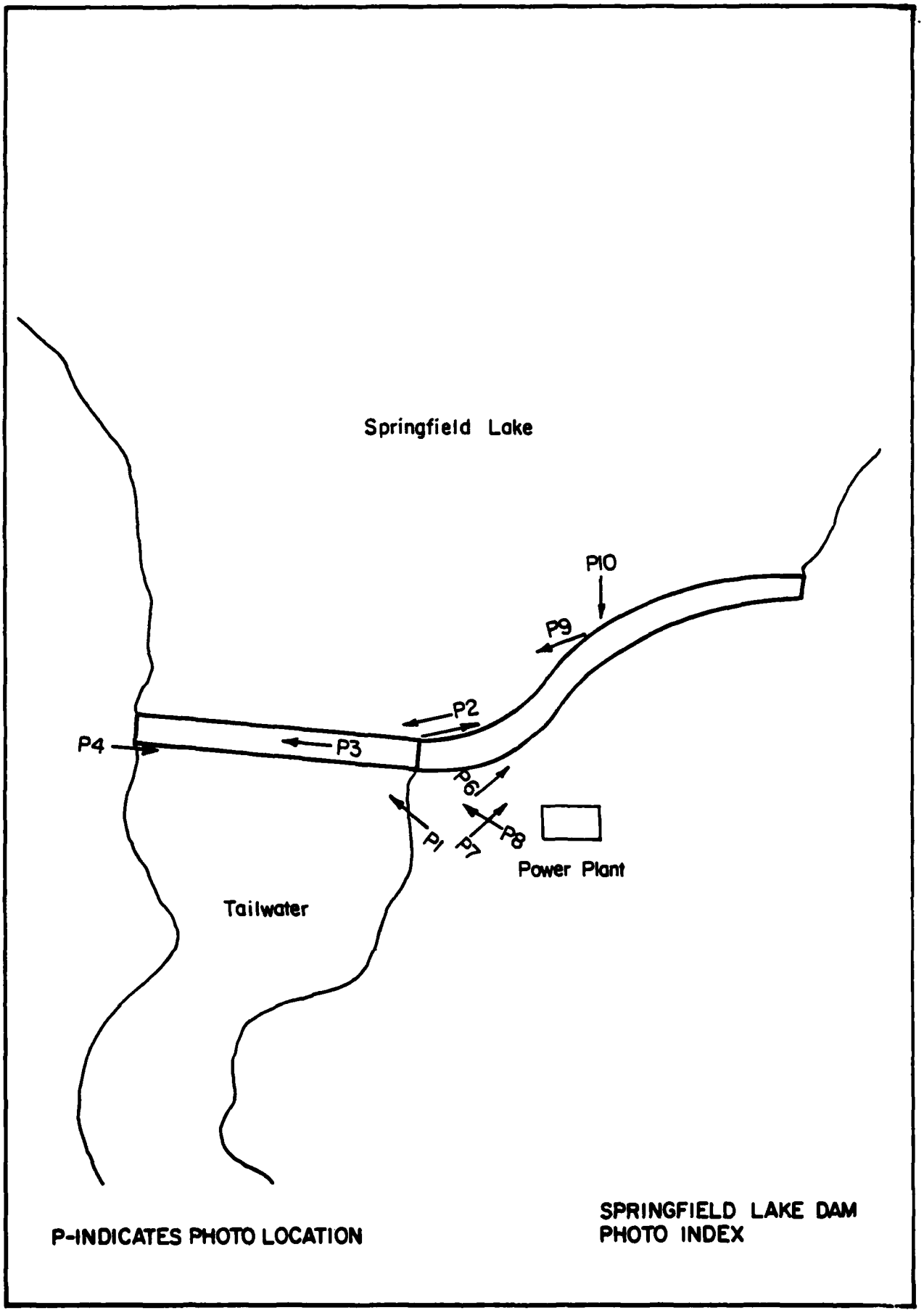
PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1140.00	1140.00	1161.20
STORAGE	2806.	2806.	20077.
OUTFLOW	0.	0.	190118.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1146.60	0.00	6144.	53106.	0.00	48.00	0.00
.30	1159.26	0.00	17717.	164557.	0.00	48.00	0.00
.60	1161.73	.53	20755.	197934.	1.00	48.00	0.00
1.00	1168.23	7.03	29938.	334105.	4.25	48.00	0.00

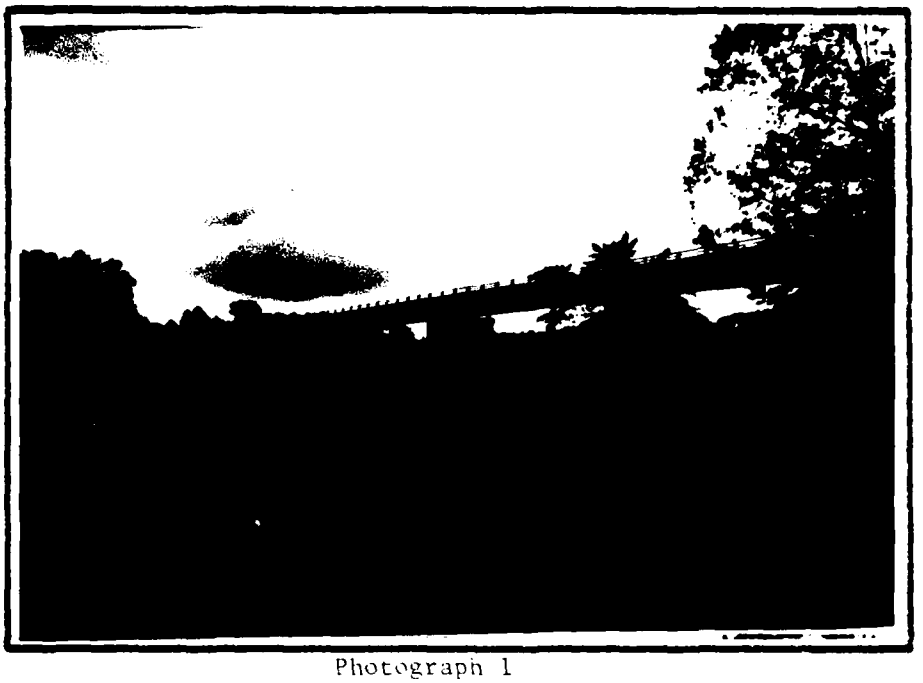
APPENDIX C

PHOTOGRAPHS



P-INDICATES PHOTO LOCATION

SPRINGFIELD LAKE DAM
PHOTO INDEX

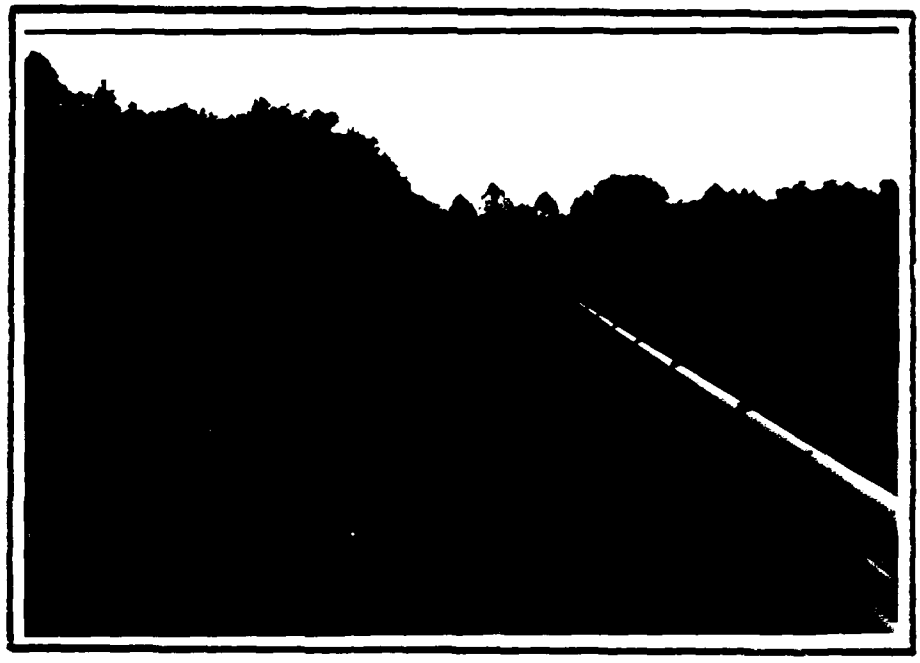


Photograph 1

Concrete gravity spillway section - downstream

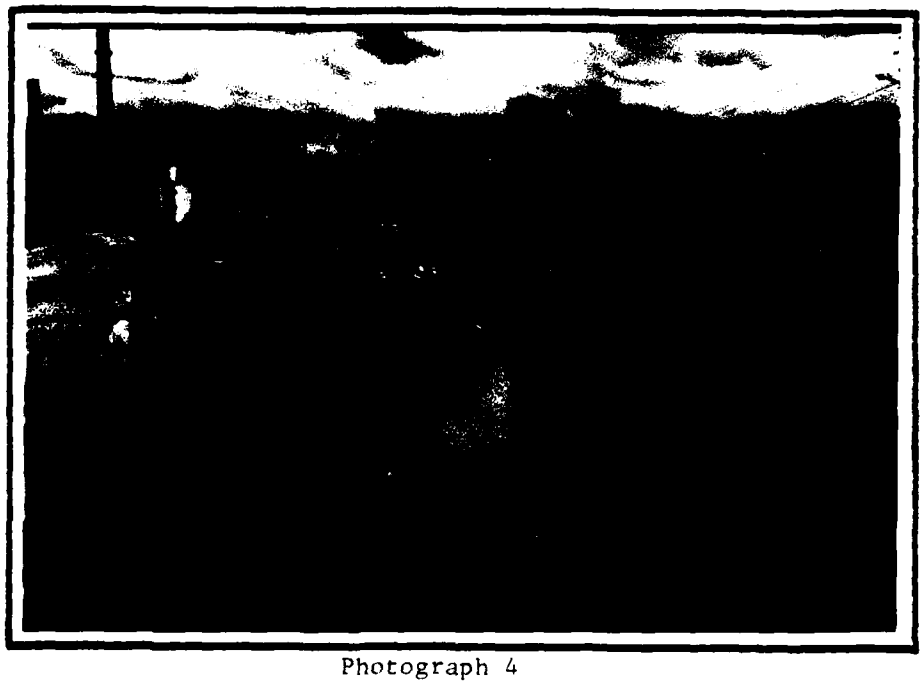
Photograph 2

Concrete gravity spillway section - upstream



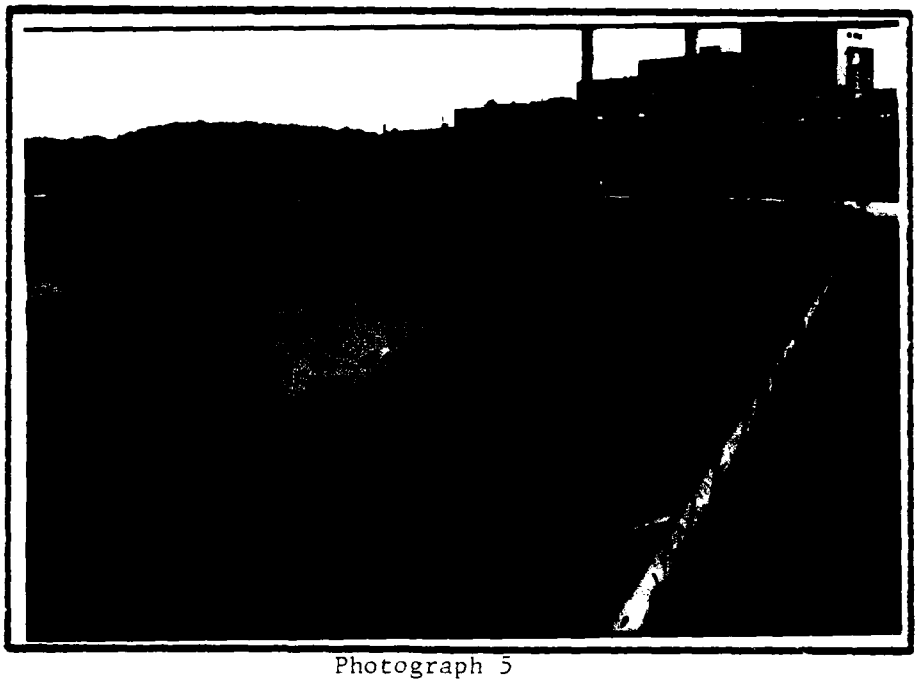
Photograph 3

Bridge carrying county road over spillway



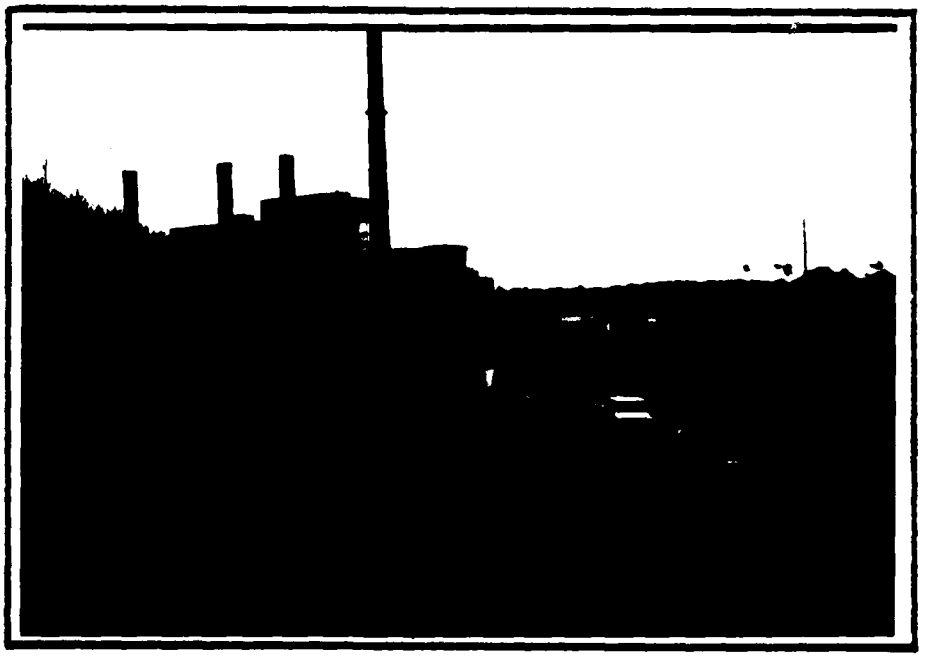
Photograph 4

Downstream area viewed from right abutment



Photograph 5

Upstream slope of earth embankment - Note powerplant discharge structure at left edge of photograph

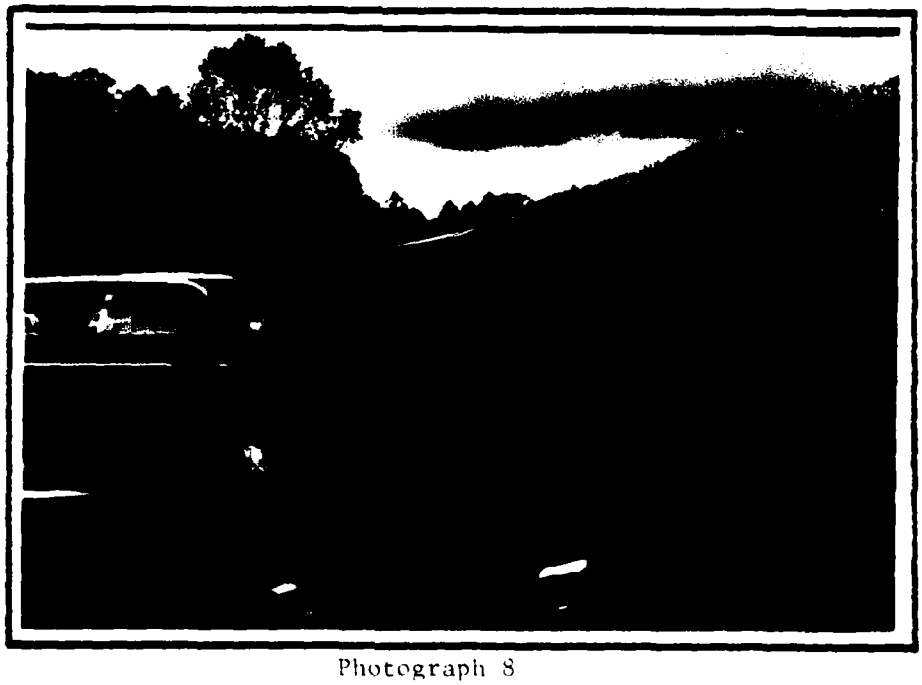


Photograph 6

Downstream slope of earth embankment - Note powerplant in background

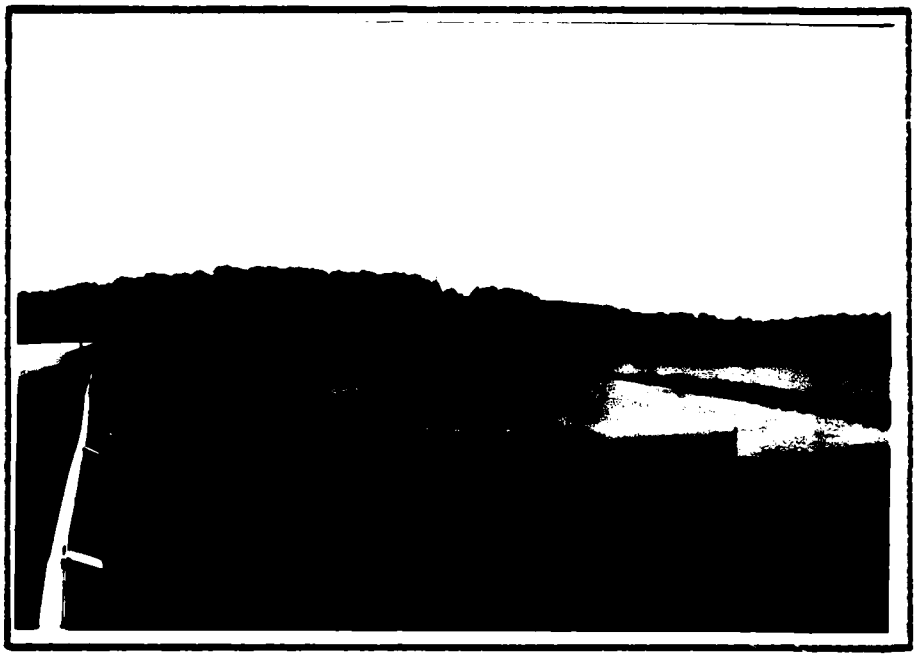
Photograph 7

Downstream slope of embankment near bend in dam



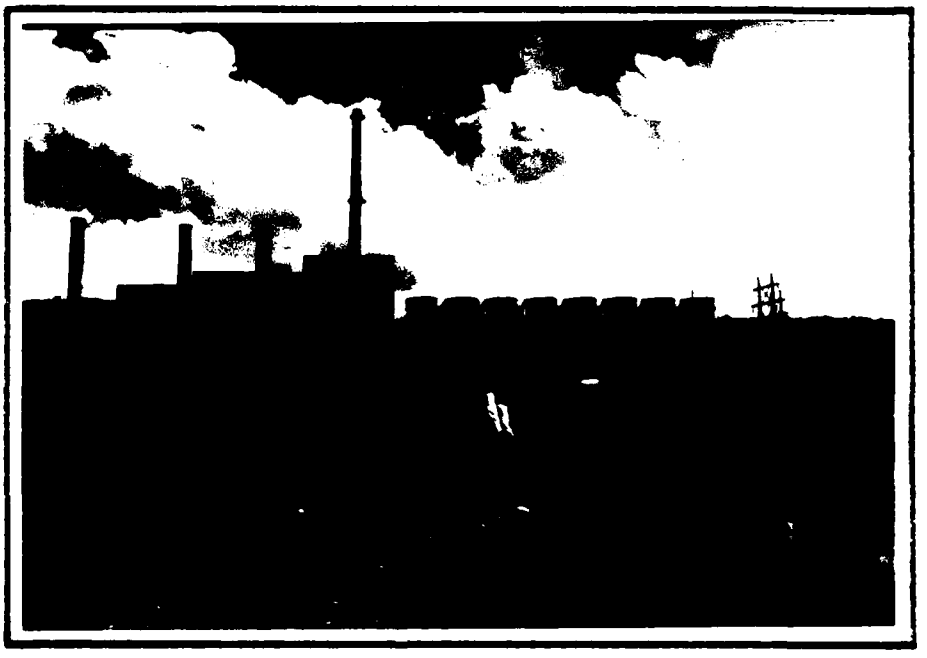
Photograph 8

Downstream slope of embankment looking toward spillway



Photograph 9

Upstream slope of dam - powerplant discharge structure in foreground



Photograph 10

Powerplant discharge structure